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CITY OF ASHEVILLE
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NORTH CAROLINA
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REPORT

on

PROPOSED EXTENSIONS OF THE WATER SUPPLY FACILITIES of the CITY OF ASHEVILLE, NORTH CAROLINA

Chas. T. Main, Inc.
80 Federal Street
Boston, Mass.

1508-4-1

February 1, 1949

INDEX

INTRODUCTION

Asheville

Asheville combines the features of a tourist and health resort with those of a trading and industrial center. The city is located in Buncombe County, North Carolina, on a plateau ringed by ranges of the Blue Ridge Mountains. The elevation of the city lies between 2100 and 2300 feet above mean sea level. The French Broad River divides West Asheville and Asheville and the Swannanoa River from the east joins the French Broad at Biltmore. The communities of Ridgecrest, Black Mountain and Swannanoa, all parts of Metropolitan Asheville, lie along this river.

Asheville lies on one of the few routes through the Blue Ridge Mountains. This was used first by the Buncombe Turnpike in 1824 and later by the railroad, which was extended to Asheville in 1880. At present the city has excellent transportation facilities, being easily accessible from the north, south and east by the Southern Railway. It lies on excellent network of paved highways and has an airport. The excellence of its transportation facilities has and will contribute materially to Asheville's growth as a tourist center.

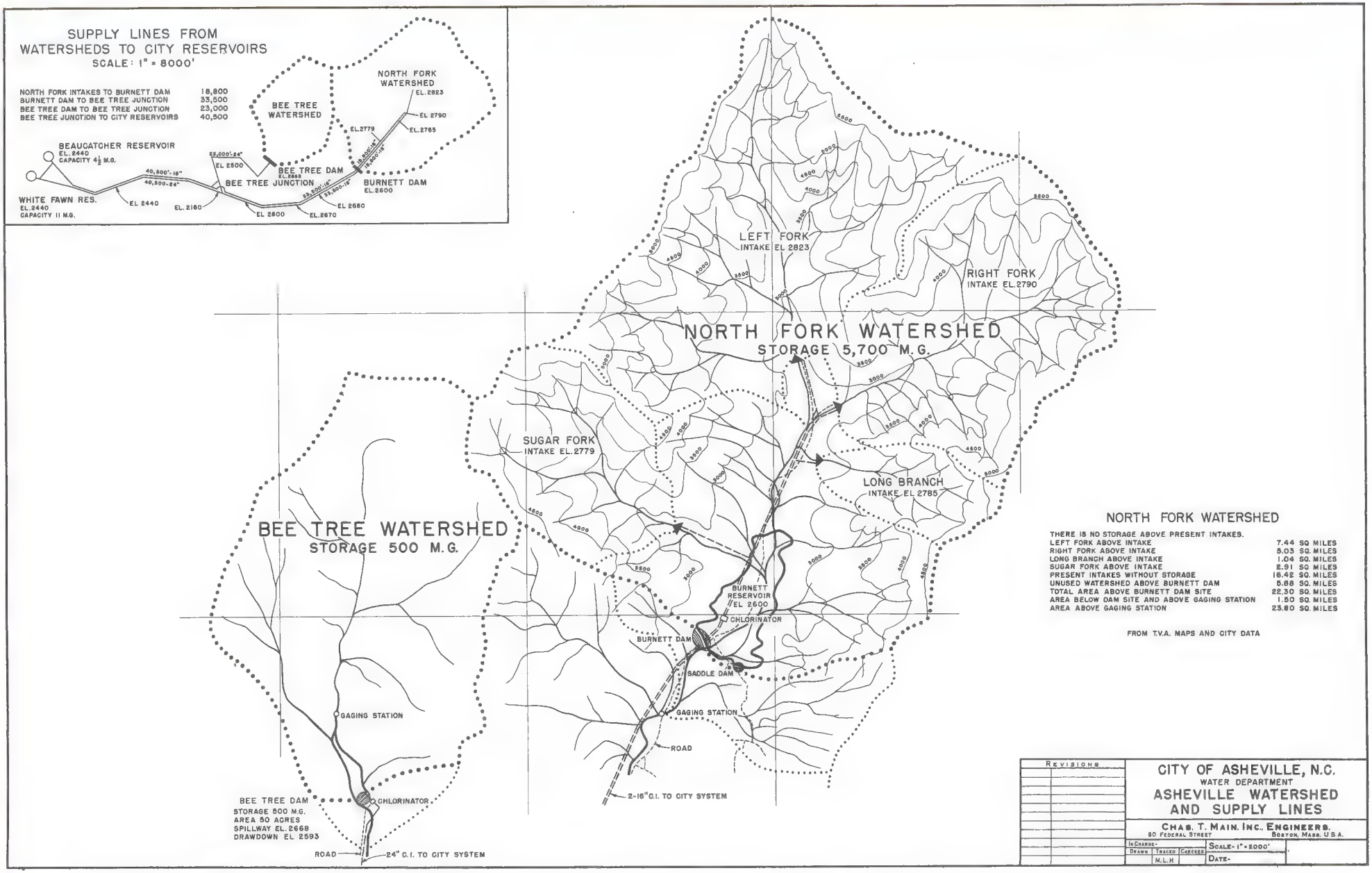
Prior to the Revolution there were no settlements in the vicinity of Asheville. After the Revolution the mountain country was opened up to settlers and in 1794 John Burton laid out a town tract of 21 acres for the seat of Buncombe County near the center of the present business district. Three years later the settlement was incorporated and named Asheville, in honor of Samuel Ashe, Governor of North Carolina, 1795-1798.

After the Buncombe turnpike was built, many residents of South Carolina, Georgia, and other southern states came to Asheville and the vicinity to escape the summer heat of the southern coastal plains so that from an early date Asheville and the vicinity has been an important resort area.

After the War between the States tobacco became an important and profitable crop, but due to poor prices the industry was abandoned until 1931 when the successful cultivation of burley tobacco in the region made this crop an important source of agricultural income. Other principal farm products of the Asheville district are livestock, dairy products, corn, hay, lespedeza, soy beans, wheat and sorghum. Lumber has always been a large source of revenue in the region and Asheville, because of its location, has been the focal point of this business. At present there are about thirty centers in Greater Asheville at which lumber produced in the surrounding area is handled, and it is estimated that six million board feet of lumber are processed through these yards each year.

The reputation and growth of Asheville, particularly as a tourist center, were increased substantially by the expenditures made by George Vanderbilt, which began in 1889, and by E. W. Grove in 1900. Mr. Vanderbilt founded Biltmore Village south of the city and developed Biltmore Estates. Mr. Grove established the residential section bearing his name and built Grove Park Inn.

Within the City of Asheville there are textile mills, a tannery, and several woodworking plants and lumber mills. Within the limits of Metropolitan Asheville there are three large textile mills and a



NORTH FORK WATERSHED

THERE IS NO STORAGE ABOVE PRESENT INTAKES.

LEFT FORK ABOVE INTAKE	7.44 SQ. MILES
RIGHT FORK ABOVE INTAKE	5.03 SQ. MILES
LONG BRANCH ABOVE INTAKE	1.04 SQ. MILES
SUGAR FORK ABOVE INTAKE	2.91 SQ. MILES
PRESENT INTAKES WITHOUT STORAGE	16.42 SQ. MILES
UNUSED WATERSHED ABOVE BURNETT DAM	5.88 SQ. MILES
TOTAL AREA ABOVE BURNETT DAM SITE	22.30 SQ. MILES
AREA BELOW DAM SITE AND ABOVE GAGING STATION	1.50 SQ. MILES
AREA ABOVE GAGING STATION	23.80 SQ. MILES

FROM T.V.A. MAPS AND CITY DATA

REVISIONS

CITY OF ASHEVILLE, N.C.
WATER DEPARTMENT
ASHEVILLE WATERSHED AND SUPPLY LINES

CHAS. T. MAIN, INC., ENGINEERS.
80 FEDERAL STREET BOSTON, MASS. U.S.A.

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SCALE- 1" = 2000'
DATE-

furniture factory. During the past year, due to the effective efforts of the Asheville Industrial Promotion Council, Inc., a cotton mill and a textile finishing plant have located in the Asheville area, and the indications are that the number of industrial plants will increase. Two large U. S. hospitals have been built in the Swannanoa district.

The growth of industry plus the growing importance of Asheville as a resort city, which has been stimulated by the development of the National Parks and T.V.A. and which will be quickened by the early completion of the Blue Ridge Parkway, point to an increasing growth of the City of Asheville itself and to a settlement and expansion at an accelerated rate of the area comprising Greater Asheville.

History of the Asheville Water Supply

Since 1903 Asheville has enjoyed water from mountain streams of such high quality in its natural state that no filtration has been required. To obtain these sources of pure mountain water it has been necessary to go to the headwaters of the Swannanoa River, some fifteen miles from Asheville, acquire two watersheds, and construct impounding dams and long pipe lines. Unquestionably, this supply of natural water of high quality has given the city, and the surrounding communities to which Asheville furnishes water, a resource which has been and will be of particular value in view of Asheville's high standing as a resort city.

In 1900 the City of Asheville water supply consisted of a filter plant at which water was pumped from the Swannanoa River some five miles east of the city. The quality of the water produced at this plant was not satisfactory and led to the decision to go to the mountains for a natural source not requiring treatment.

Seven square miles of property were purchased on the North Fork of the Swannanoa River. A small diversion dam was built on the Right Fork and a sixteen inch cast iron line was laid to the 300,000 gallon steel reservoir on Beaucatcher Mountain to which water flowed by gravity. In order to conserve metal in the line, it was laid on the side of the valley, with high points above Elevation 2600, rather than the valley floor. This pipe line was completed in 1903 and resulted in a marked improvement in the water delivered to the consumer. The high quality and purity of Asheville water were a source of civic pride and an advertised attraction. Asheville soon gained a national reputation for the quality of its water, At the same time the citizens of Asheville and the surrounding communities served have become accustomed to an untreated water of high quality.

No stream flow data was available on the North Fork and the amount of water available during periods of low flow was underestimated. During the fall of 1904 the supply was not adequate to meet the demand and Asheville started on a forty-four year search for the quantity of good upland water necessary to supply the demands of the growing city and the surrounding water districts.

To obtain additional watershed above the intake, a channel was cut from the Left Fork to the North Fork Intake and by 1910 a large portion of the Left Fork Watershed and that of Long Branch had been purchased by the city. In 1912 these two sources were connected to the system by means of a wooden pipe, making the total watershed above the intakes 14 square miles, but since there was no storage the safe capacity of the system was limited to the natural flow of this watershed during a period of low flow, usually July and August. For most of the year an ample supply was available.

In the period 1912-1915, as a result of an increase in consumption accompanied by droughts, the city experienced several periods of water shortage, which emphasized the need for additional supply. In 1916 the city purchased property on the headwaters of Bee Tree Creek. By this purchase 7.6 square miles of watershed were added to the system. During the next five years this watershed was cleaned up, an intake built and a 16 inch line laid to a new five million gallon distribution reservoir on Beaucatcher Mountain near the old steel standpipe. The Bee Tree supply was turned into the city system June 1, 1921. In that same year sterilization was incorporated into the system by means of chlorinators installed at the North Fork and Bee Tree Intakes. See the accompanying map "Asheville Watershed and Supply Lines".

Again the increase in demand outstripped the enlarged supply. For the first time a storage reservoir was planned for the purpose of impounding water hitherto wasted because of the limited capacity of the pipe lines. In 1924 the city started the construction of a reservoir on Bee Tree Creek.

In 1925, before the Bee Tree Dam was completed, one of the driest years of record was experienced and the city was seriously short of water. At that time the population of the City of Asheville was nearly 35,000 persons and the resort visitors amounted to an additional 30% of this figure during the tourist season. In addition, water was being supplied to some users in the county. To augment the inadequate supply, emergency pumping plants were installed. In the following year a spring drought occurred. To further add to the supply, an emergency filter plant was constructed to purify water from the French Broad River

at a point five miles from Asheville. In addition, a temporary pumping station was installed on the North Fork of the Swannanoa River near the site of the present gaging station. By means of a booster pump, the capacity of the 16 inch main was increased from three million gallons per day to five million gallons per day, and by the use of a second pump water was pumped from the river near the pump house and boosted into the mains at this point.

In November 1927, Bee Tree Reservoir was completed. At the same time an additional nine square miles of watershed on the North Branch was condemned for future development, making the total watershed holdings of the city on the North Branch about thirty square miles. This reservoir has an effective usable capacity of the storage reservoir of about 500 million gallons and was first filled in April 1928. At the same time a 24 inch main was laid from the Bee Tree Reservoir to the city. After these additions to the system were completed, the capacity of the pipe lines was about 10.5 million gallons per day, and the safe yield of the system in a very dry period such as 1930, about 9.0 million gallons per day. The White Fawn Distribution Reservoir was built this same time. These improvements and additions to the supply were designed by Dr. Charles E. Waddell, Consulting Engineer of Asheville.

During this period of expansion the importance of obtaining accurate data on the quantity of rainfall and stream flow was realized, and a program was started in 1925 of installing rain gages, gages to record the flow of Bee Tree Creek and the North Fork, as well as meters to measure the flow in the pipes conveying water to the city. As a result of this farsighted policy, complete data has been obtained upon

which accurate studies of the capacity of new sources of supply can be made.

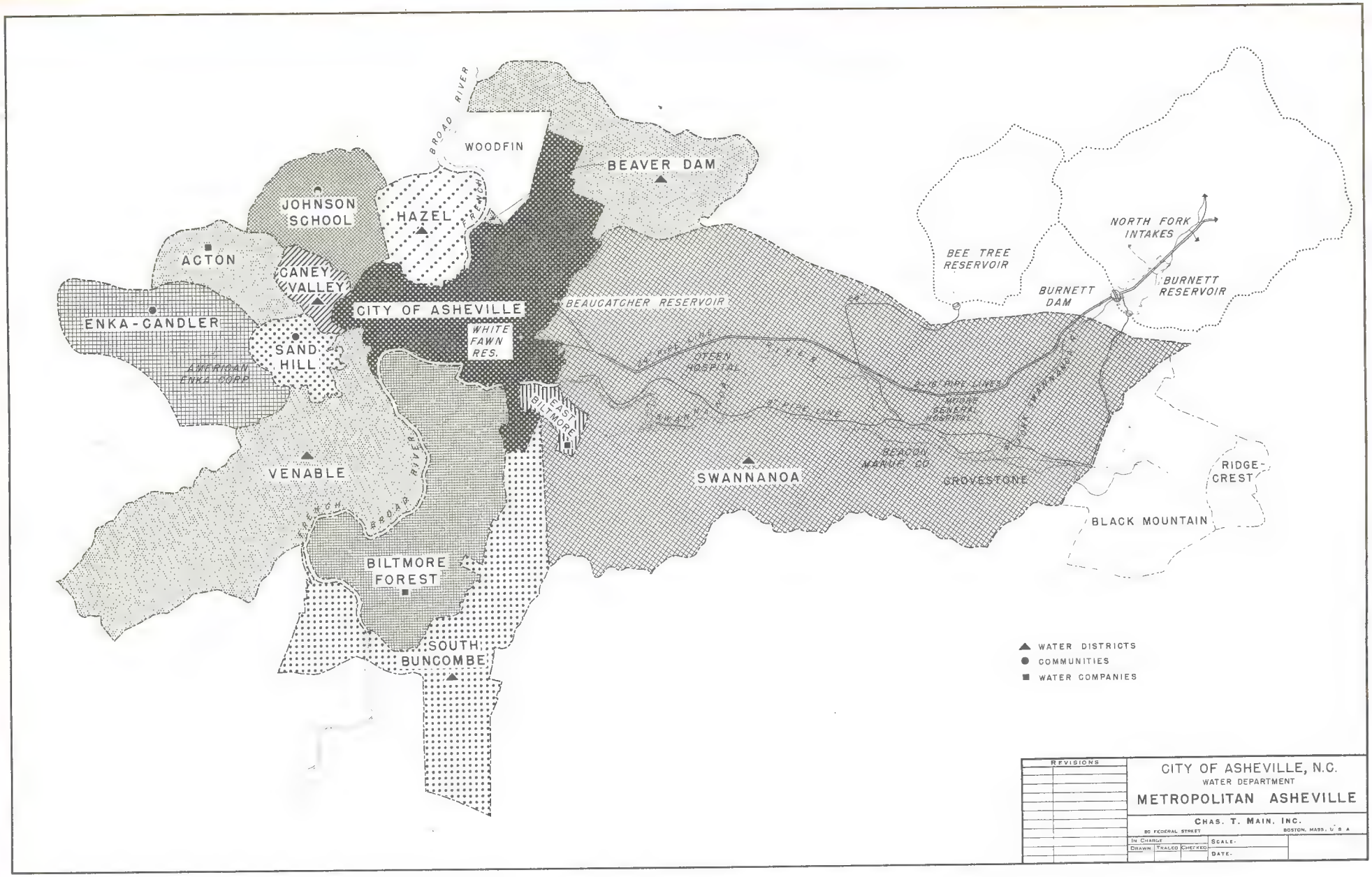
In the late 1920's a county system of water and sewer lines was laid out extending beyond the city into the county to serve the growing suburban population. During this period Buncombe County began to industrialize with the accompanying need for water, so the demand increased.

In 1934 the original 16 inch line from Bee Tree was relaid to the North Fork Intake to augment the carrying capacity of the mains from the North Fork at the same high level as the original 16 inch line. During that same year, 1934, modern chlorine ammonia treatment plants were placed in operation on the North Fork and at Bee Tree, thus making it possible to sterilize the water completely and eliminate the possibility of disease by water-born bacteria.

In 1939, on the North Fork Watershed, an intake was built on Sugar Fork and an 8 inch connection built, thus adding a small increase of supply to that supply. No additional source of supply has been built since that time.

The present system has a total yield in a dry year such as 1930 of about 9.3 million gallons per day, and the present demand of the system is somewhat greater. In the year ending June 30, 1948, the average gross consumption was 10.4 million gallons per day.

So far during this period of great demand the city has been fortunate that the rainfall and stream flow have been above average so that the supply has been sufficient. But if a period of less than average rainfall should occur, in view of the ever increasing demand



REVISIONS	

CITY OF ASHEVILLE, N.C.
WATER DEPARTMENT
METROPOLITAN ASHEVILLE

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for water by domestic consumers and the increased demands of industry in Metropolitan Asheville, the situation would be very critical. An already serious situation is aggravated by the fact that the period of maximum water consumption is during the tourist season, the summer months, and this is normally the period of lowest flow from the watersheds. The city is aware of the seriousness of the situation and for that reason is planning to further increase the supply by building a dam and reservoir on the North Fork. Until this dam is built, the demand for water will be greater than the supply in any year unless the rainfall is greater than average.

Summary

The territory served by the Asheville Water Department covers the city itself and the six water districts, South Buncombe, Swannanoa, Beaverdam, Hazel, Venable, and Caney Valley. In addition, the communities of Enka-Candler, Sand Hill, and Johnson School, and the East Biltmore Water Company are provided with water and emergency service is furnished to Black Mountain, Ridgecrest and Woodfin.

The source of water is from two watersheds about fifteen miles east of the city, one on Bee Tree Creek, fully developed, drainage area 7.6 square miles, storage 500 m.g., yield 6 m.g.d.; the other on North Fork, a tributary of the Swannanoa River, partially developed, 16.4 square miles of 22.3 square miles drainage area, four intakes, no storage, yield 4 m.g.d.

The present supply lines from the watersheds to the city reservoir consist of one 24 inch line from Bee Tree Reservoir and two 16 inch lines from the North Fork Watershed. The combined capacity of the gravity supply lines is about 12 m.g.d.

The city distribution system consists of a network of 232 miles of pipe ranging in size from 24 inches to 2 inches, and the county distribution system, which supplies practically the whole county with the exception of Woodfin and Weaverville Sanitary Districts and the Town of Black Mountain, is a network of 231 miles of pipe, 18 inches to 2 inches in size, and connected with the city system. The distribution lines, including the supply lines, total over 500 miles for the entire system. All commercial and domestic consumption is metered.

For some time the City of Asheville has been in need of additional water supply facilities. The present demands for water have increased from 8.5 m.g.d. in 1945 to over 10 m.g.d. in 1948. The safe yield of the system in the dry year of 1930 was 9.3 m.g.d. and for the average of the seven driest years in the past twenty years was 10.1 m.g.d. The above figures indicate that present facilities are barely sufficient to meet present demand and that no margin is available to meet the future demands on the system.

In order to plan the necessary extensions of the existing water supply facilities of the City of Asheville to meet the present and future demand, this report approaches the problem in three parts:

1. Forecast of population and water consumption.
2. Proposed facilities required to insure supply.
3. Recommended ways and means of financing new construction.

PART I - FORECAST OF POPULATION AND WATER CONSUMPTION

Population

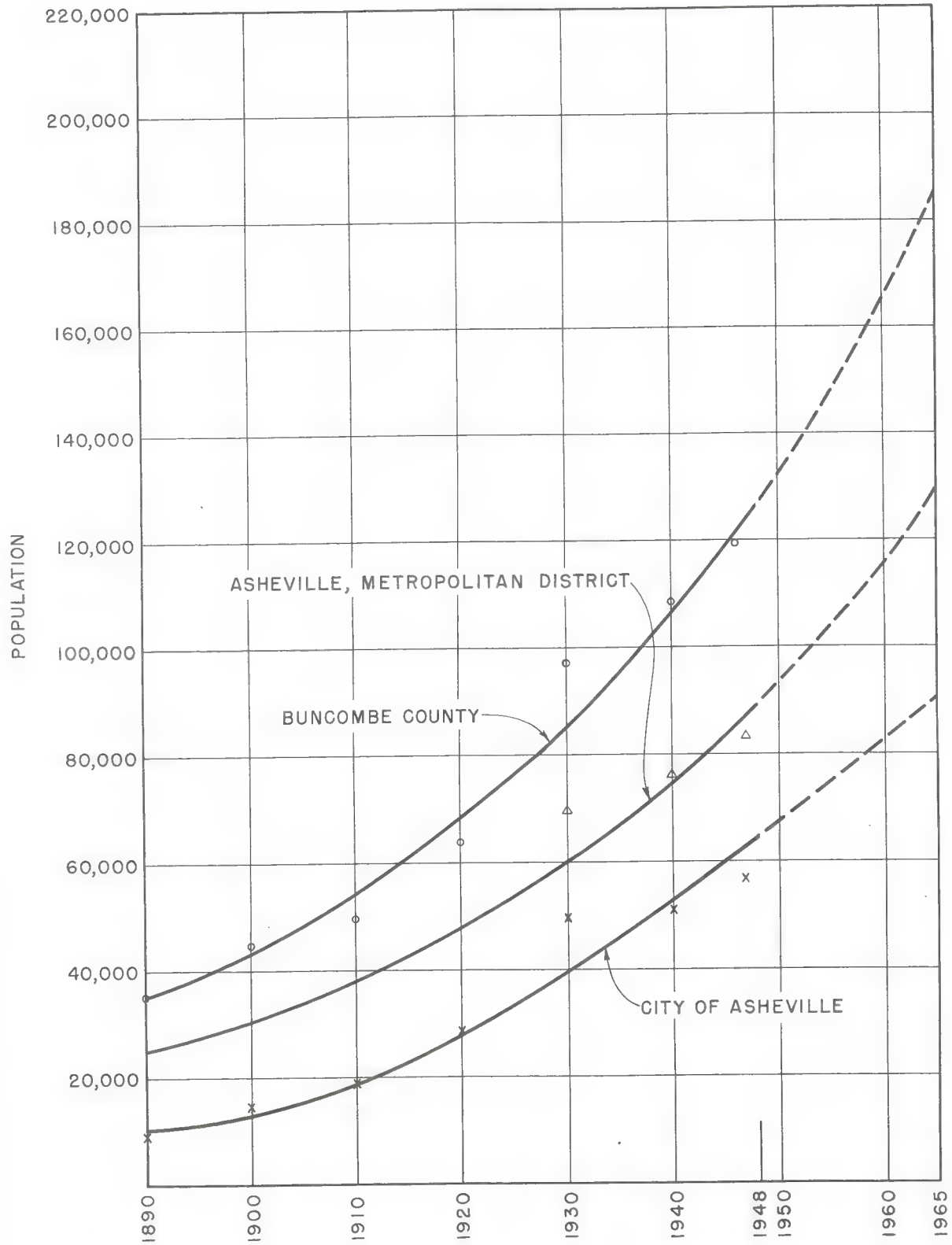
The population figures and other available data indicate that the growth of the Asheville Metropolitan District and Buncombe County in recent years has been at a faster rate than of the City of Asheville itself. This tendency has been noted in other similar metropolitan districts and may be largely accounted for by the following factors:

a. The present trend of industry in establishing new plants, to locate in the country where large areas of low cost land are available. This makes possible a plant layout with one story buildings, large parking areas, and ample room for expansion.

b. The movement of families out of cities into suburban areas where it is possible to build on larger lots or even establish small farms. The networks of modern all-weather roads which have been built in the past twenty years have accentuated this tendency since it is feasible to commute to work by auto and by bus for distances up to twenty-five miles. As a result of this long distance commuting, few compact mill villages are being built near new industries. In general, it may be said that the suburbs around cities are increasing at a faster rate than the cities, and Asheville is no exception to this rule.

c. In resort cities such as Asheville, the continuing growth of the tourist business is an important factor and in this the tourist camps are a significant new development. These very definitely tend to be located outside of the city limits where large areas of land are available.

CITY OF ASHEVILLE, N.C.
POPULATION



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In considering this growth, the best data available for a period of years on which forecasts may be based is for the City of Asheville and for Buncombe County. Some supporting data is available from the records of growth of other cities and counties in this general region. However, due to the fact that Asheville, in addition to being a trading and manufacturing center, is also a resort center, there are few cities which are strictly comparable.

Records of the population of the City of Asheville and Buncombe County are tabulated below from 1890 to date and also for the Asheville Metropolitan District for the period available.

	Buncombe County	City of Asheville	Asheville Metr. District
1890	35,266	10,235	
1900	44,288	14,694	
1910	49,798	18,762	
1920	64,148	28,504	
1930	97,937	50,193	70,537
1940	108,755	51,310	76,324
1948 Estimated	127,000	64,400	86,000

This same data has been plotted on the diagram "Population" on the opposite page.

For purposes of comparison, tabulations are given below showing the relative growth of a number of southern communities. Estimated figures for 1947 or 1948 are included where available.

Growth of Cities

City	State	1930 Population	1940 Population	% Increase 1930-1940	1947 *Population	% Increase 1930-1947
Asheville	N.C.	50,193	51,310	2	+64,400	28
Durham	N.C.	52,037	60,195	16	72,000	38
Kingsport	Tenn.	11,908	14,404	21	18,000	51
Winston-Salem	N.C.	75,274	79,815	16	93,000	23
Charlotte	N.C.	82,675	100,899	22	115,000	39
Danville	Va.	22,247	32,749	47	37,000	66
Chattanooga	Tenn.	119,798	128,163	7	142,000	18
High Point	N.C.	36,750	38,449	4	47,500	29
Greenville	S.C.	29,500	34,500	7	44,500	51
Spartanburg	S.C.	28,723	32,249	12	42,000	46
Knoxville	Tenn.	105,802	111,580	5	168,000	59

*Estimated

+1948

Growth of Metropolitan Districts

Asheville	N.C.	70,537	76,324	8	86,000	22
Durham	N.C.	67,196	80,224	20	100,000	49
Chattanooga	Tenn.	155,798	175,163	12	202,000	30
High Point	N.C.	39,000	41,990	8	52,000	33
Greenville	S.C.	61,000	84,000	38	115,000	88
Spartanburg	S.C.	*40,000	*53,951	35	75,000	87

*Estimated

Considering first the population within the city limits, it is evident that the growth of Asheville since 1930 compares favorably with the older cities where there has not been a notable increase in industry. Furthermore, in predicting the future growth of Asheville, it is reasonable to suppose that with the growing industrialization of the South, the progress which is now being made in attracting industries into the Asheville area and the growth of those already established, the future growth of Asheville and the territory comprising the metropolitan district will be at a rate comparable to that shown by some of the more highly industrialized cities in the region.

The figures for the metropolitan districts emphasize the point made above, the tendency for population to spread out into the county, which results in a faster rate of growth in the county than in the city.

These population figures and estimates do not include the transient tourist population. It is estimated that during the season, the population of Metropolitan Asheville is increased about 20% due to tourists. This important factor in the economy of the region, from the point of view of water supply, offers an added complication to the problem of water consumption.

Considering these factors and the available data, the growth of Buncombe County from 1890 to 1947 offered the best long term trend of growth of the Asheville Metropolitan District in the future. On this basis, the population of the Asheville Metropolitan District in 1965 is estimated to be 130,000.

A similar projection of the past population of the City of Asheville since 1890, based on the average rate of growth since 1930, indicates an

estimated population of the city of about 90,000 persons in 1965. This somewhat slow rate of growth within the city is in accordance with the general tendencies discussed above where it was noted that suburban population has increased faster than urban population.

These estimates of future population are used later in this report as one of the bases of the estimates of water consumption in 1965 for the city and the territory served by the Asheville Water Department.

Water Consumption

Present Use. The forecasts of the future demands for water have been based on the population studies and estimates previously described and an analysis and projection of the available data on the city's use of water.

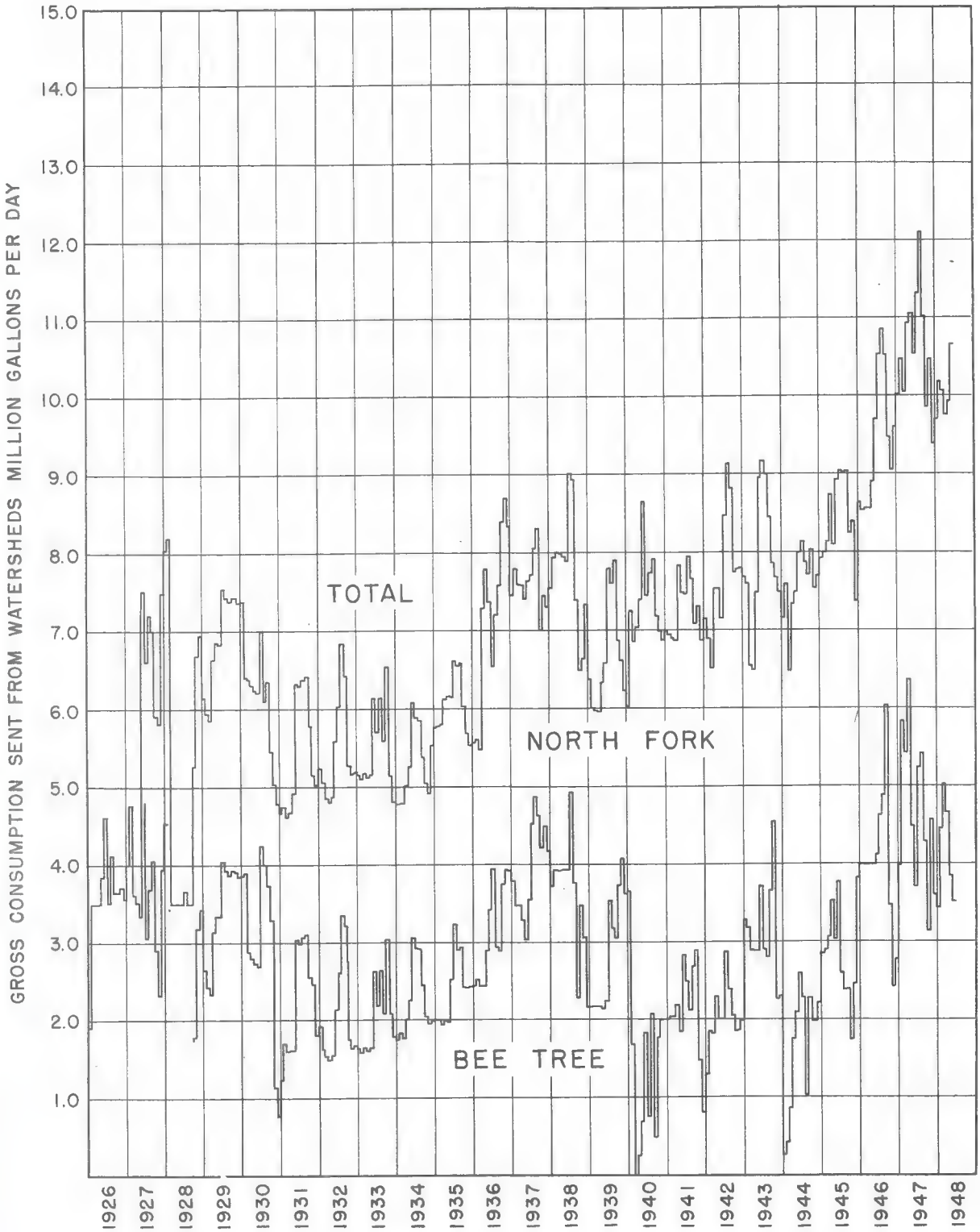
Two long term records of water consumption are available on which estimates of future consumption can be based:

1. "Gross Consumption". This is a record of the total quantity of water collected at the various sources and sent to the city and the water districts through the two sixteen inch pipe lines from the North Fork and the 24 inch line from Bee Tree Reservoir. These figures are obtained from daily readings of meters on each of the transmission lines.

2. "Metered Consumption". This record is obtained by adding together the readings of all the water meters in the city, and the water districts and communities outside of the city. These figures form the basis of the monthly bills of the Water Department.

Gross Consumption. As the result of the excellent system of recording water meters installed by the city, accurate records of the total

CITY OF ASHEVILLE, N.C.
GROSS CONSUMPTION 1926-1948



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JANUARY 1949

amount of water collected at the source are available from 1926 to date. The average yearly "Gross Consumption" in million gallons per day is tabulated below. This same data is shown graphically by months on the plate on the opposite page.

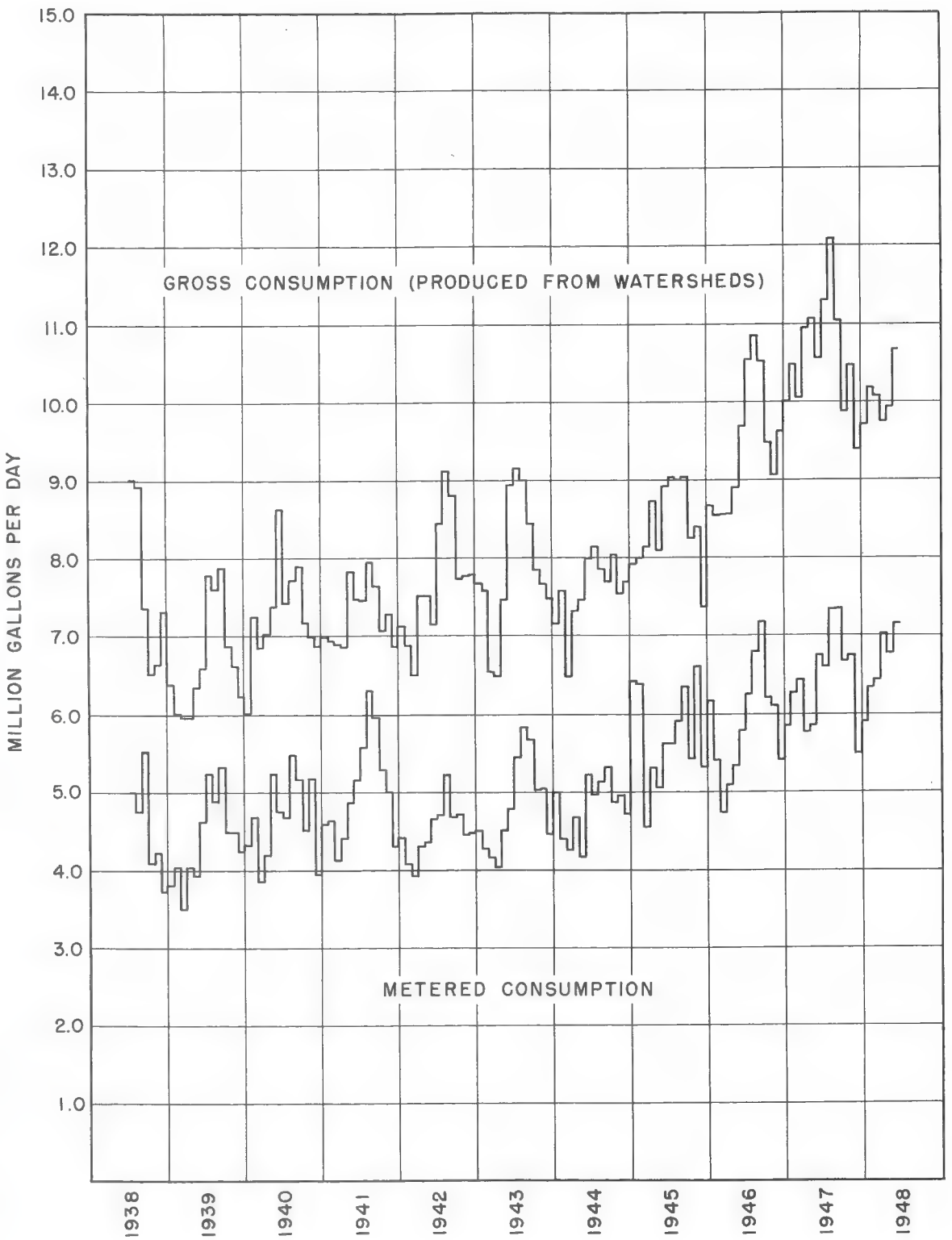
GROSS CONSUMPTION

Calendar Year	Bee Tree - Average Million Gallons Per Day	North Fork - Average Million Gallons Per Day	Total Average Million Gallons Per Day
1926	--	3.59	3.59
1927	2.08	3.49	5.57
1928	1.59	3.51	5.10
1929	3.41	3.50	6.91
1930	3.00	3.21	6.21
1931	2.24	3.17	5.41
1932	2.06	3.38	5.44
1933	2.06	3.42	5.48
1934	2.25	3.03	5.28
1935	2.41	3.68	6.09
1936	3.14	4.03	7.17
1937	3.98	3.64	7.62
1938	3.60	4.16	7.76
1939	2.88	3.83	6.71
1940	1.45	5.84	7.29
1941	2.15	5.16	7.31
1942	2.04	5.68	7.72
1943	3.13	4.76	7.89
1944	1.67	5.93	7.60
1945	2.90	5.62	8.52
1946	4.04	5.40	9.44
1947	4.69	5.94	10.63
1948*	4.16	5.88	10.04

*First 6 months

An examination of the monthly plottings indicates that the use is always higher in the summer months. This is generally true in all cities due to greater domestic use during warm weather, the watering of lawns and gardens; but in Asheville, normal summer use is increased due to the tourist and recreational business.

CITY OF ASHEVILLE, N.C.
GROSS AND METERED CONSUMPTION



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Metered Consumption. Figures of "Metered Consumption" are available for the ten year period ending June 30, 1948 and for a few scattered years back to 1928.

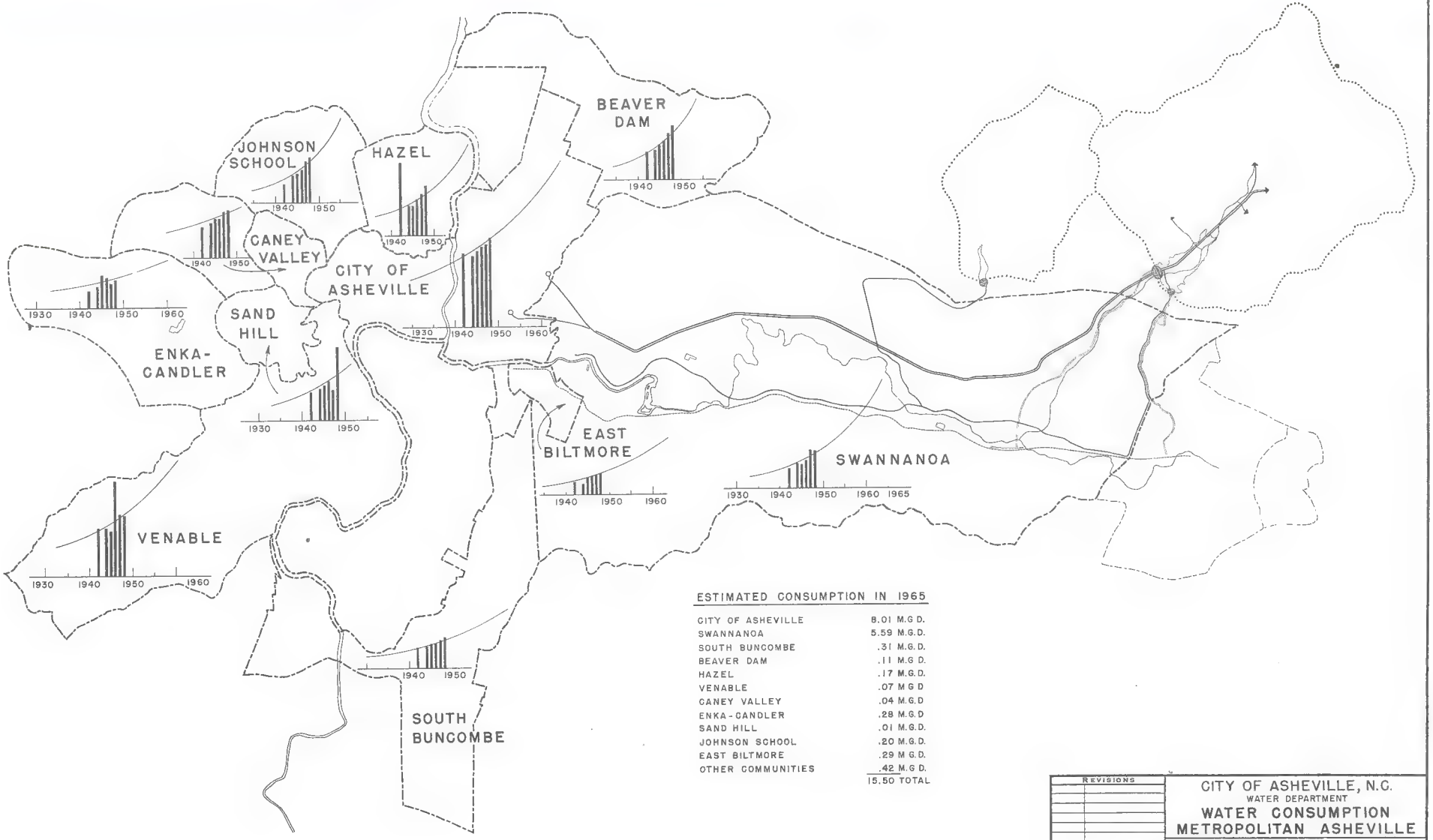
ANNUAL METERED CONSUMPTION

Year	Average Million Gallons Per Day	Remarks
1928	3.78	Year ending August 31
1929	4.35	" " " "
--		
1932	3.45	10 months ending June 30
--		
1934	3.30	Year ending June 30
--		
1939	4.27	" " " "
1940	4.65	" " " "
1941	4.74	" " " "
1942	4.86	" " " "
1943	4.55	" " " "
1944	4.94	" " " "
1945	5.27	" " " "
1946	5.65	" " " "
1947	6.24	" " " "
1948	6.58	" " " "

These figures have also been plotted by months for the past ten years and are shown graphically on the plate on the opposite page.

The monthly figures of "Gross" and "Metered Consumption" have been plotted, see graph on opposite page. The difference between these two graphs is the "Unaccounted For" water. It should be pointed out that this quantity includes water, not metered, used by the City of Asheville and certain unmetered uses in the county. Within the city, water not metered is used in the city swimming pools, and drinking fountains, for watering city parks, for street flushing, and to a limited extent for the flushing of storm and sanitary sewers and cleaning out dead end water lines. In the county, water is used for cleaning out dead end water lines and for flushing out storm and sanitary sewers. This last use, which is dictated by public health requirements, is much greater in the county due to the fact that the connections to the county sewers are more widely scattered. Thus the flow of sewage is small and to keep the lines clean, additional flow is produced by connections to water lines. We are informed that many county sewer lines were originally laid with water line connections.

In addition to these unmetered uses of water, there is a certain amount of unavoidable loss between the amount of water produced and the water which can be accounted for. In Asheville, as has been discussed, a substantial amount of water is used which is not metered. Over and above that, in all pipe networks there are losses which are directly proportional to the number of miles of pipe laid, the age of the system and the pressure on the system. Thus in a gravity supply such as Asheville, with the long supply lines from the sources to the city and districts, and high pressures up to 200 pounds, it is to be expected that the losses will be higher than in a supply which is pumped where the source is frequently close at hand and the pressures low. Furthermore,



ESTIMATED CONSUMPTION IN 1965

CITY OF ASHEVILLE	8.01 M.G.D.
SWANNANOA	5.59 M.G.D.
SOUTH BUNCOMBE	.31 M.G.D.
BEAVER DAM	.11 M.G.D.
HAZEL	.17 M.G.D.
VENABLE	.07 M.G.D.
CANEY VALLEY	.04 M.G.D.
ENKA-CANDLER	.28 M.G.D.
SAND HILL	.01 M.G.D.
JOHNSON SCHOOL	.20 M.G.D.
EAST BILTMORE	.29 M.G.D.
OTHER COMMUNITIES	.42 M.G.D.
	15.50 TOTAL

REVISIONS	

CITY OF ASHEVILLE, N.C.
WATER DEPARTMENT
WATER CONSUMPTION METROPOLITAN ASHEVILLE

CHAS. T. MAIN, INC.
80 FEDERAL STREET BOSTON, MASS., U. S. A.

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the territory served by the City of Asheville is large, residences are spread out due to the hilly terrain, which results in longer lengths of pipe line compared to a city on relatively flat land laid out with orderly compactness.

For the purposes of comparison, a table has been prepared for cities of comparable size, with gravity supply lines giving the miles of water mains per 1000 population, the loss in gallons per day per capita, and the loss in gallons per day per mile of water main. These figures are for the year 1945, the latest year for which information is available.

		Miles of Main per 1000 Pop.	Loss per Capita G.P.D.	Loss per Mile of Main G.P.D.
Asheville,	N.C.	6.00	33.6	5,600
Fitchburg,	Mass.	2.33	54.7	23,450
Ansonia,	Conn.	2.01	8.8	4,350
Bloomfield,	N.J.	1.92	36.6	19,100
Gloversville,	N.Y.	2.42	18.0	7,350
Greeley,	Colo.	3.12	17.5	5,520
Little Falls,	N.Y.	1.48	109.6	73,200
Little Rock,	Ark.	2.43	14.0	5,810
Mt. Vernon,	N.Y.	1.32	8.4	6,390
Norwalk,	Conn.	3.86	6.5	1,640
Salem,	Ore.	2.60	68.8	26,400
Stamford,	Conn.	2.37	8.8	3,740
Tamagua	Pa.	1.64	7.6	4,590
Ventura,	Cal.	4.90	14.5	2,905
Winchester,	Mass.	4.06	14.3	3,510
Gr. Junction,	Colo.	2.37	69.0	28,950

Increase Outside of City. In the discussion of "Forecast of Population" it was pointed out that the population is increasing faster outside of the city than in Asheville. An analysis of the water consumption figures, the "Metered Consumption" indicates that the consumption of water also is increasing and at a much higher rate than inside of the city limits; in fact, were it not for this outside growth, the water

situation would not be as acute and the present supply would not immediately need the substantial addition now planned.

A breakdown showing the distribution of "Metered Consumption" between the city itself and the various subdivisions outside of the city has been prepared for the years 1942 and 1944 to 1948 inclusive. These figures are given below and indicate the relative growth of water use in the water districts and communities outside of Asheville compared to the city itself.

	Average Daily Consumption in Million Gallons per Day					
Year Ending June 30	1942	1944	1945	1946	1947	1948
District						
South Buncombe	0.10	0.10	0.11	0.11	0.13	0.14
Swannanoa	0.97	1.21	1.15	1.34	1.84	1.82
Beaverdam	.01	.01	.01	.02	.02	.02
Hazel	.07	.03	.03	.03	.04	.05
Venable	.02	.02	.02	.05	.03	.03
Caney Valley	.01	.02	.02	.02	.02	.02
Enka-Candler	.08	.10	.16	.15	.12	.13
Sand Hill	.01	.01	.01	.01	.01	.01
Johnson School	.02	.02	.03	.03	.04	.04
East Biltmore	.06	.05	.08	.08	.09	.10
Sum of Above	1.35	1.57	1.62	1.84	2.34	2.36
City of Asheville	3.51	3.37	3.65	3.81	3.90	4.22
Total*	4.86	4.94	5.27	5.65	6.24	6.58

Similar tables showing the breakdown and increase in the revenue received and the number of meters are given below.

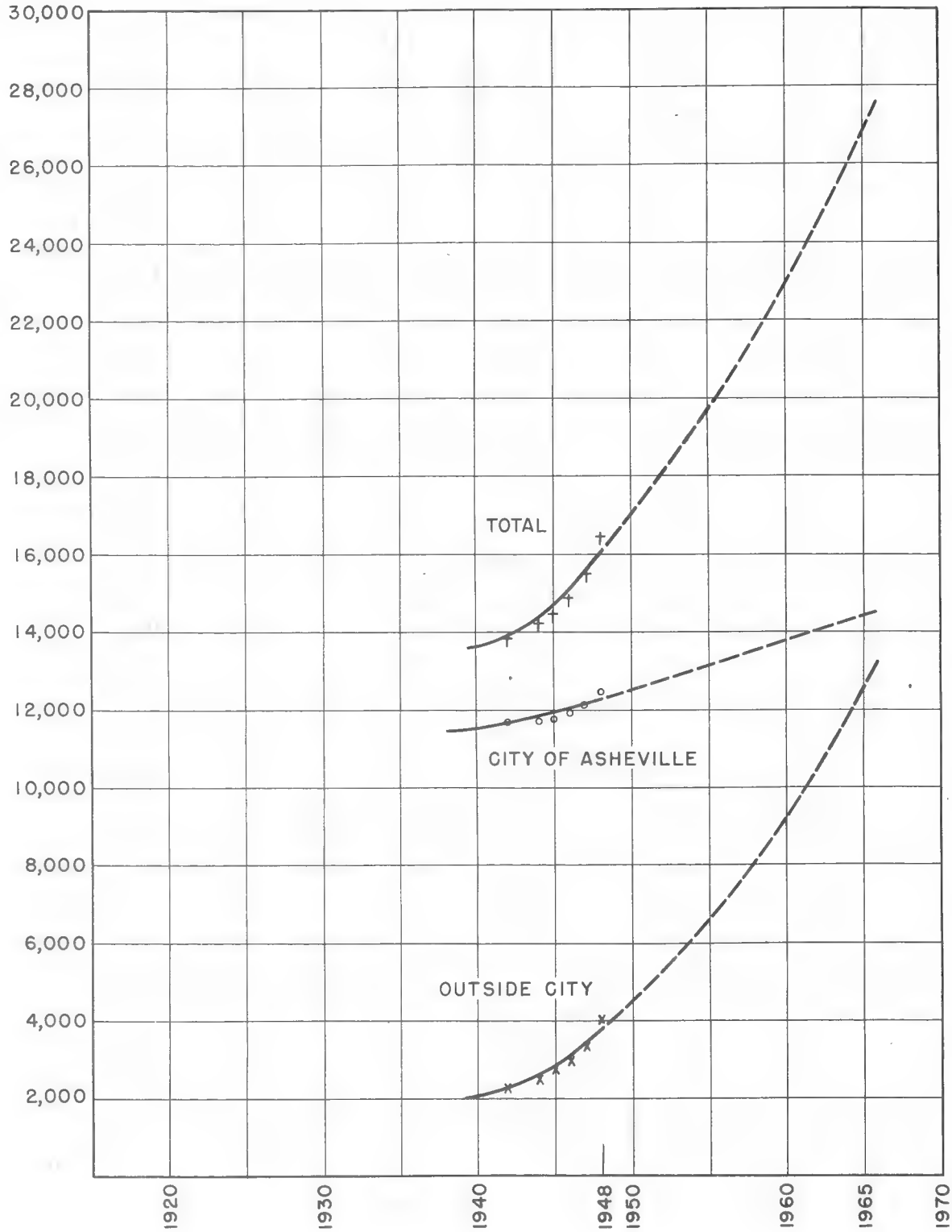
REVENUE (WATER SALES)

Year Ending June 30	1942	1944	1945	1946	1947	1948
S. Buncombe Water Dist.	$ 11,858	$ 13,714	$ 14,270	$ 16,266	$ 20,054	$ 24,163
Swannanoa Water Dist.	44,701	57,802	60,592	67,539	97,553	109,601
Beaverdam Water Dist.	2,100	2,409	2,720	3,010	3,723	4,517
Hazel Water Dist.	3,981	4,167	4,675	5,481	6,563	7,499
Venable Water Dist.	3,024	2,999	3,238	5,507	4,381	4,818
Caney Valley Water Dist.	1,956	2,341	1,846	2,675	3,532	4,246
Enka-Candler Community	4,359	5,574	7,980	7,732	8,086	9,674
Sand Hill Community	516	531	569	674	834	1,038
Johnson School Community	1,095	1,504	3,105	2,933	4,000	4,516
E. Biltmore Water Co.	2,541	2,534	3,489	3,633	4,463	4,898
Total of Above	$76,131	$93,575	$102,484	$115,450	$153,189	$174,970
City of Asheville	325,714	335,120	360,399	378,633	457,215	501,336
Total	$401,845	$428,695	$462,883	$494,083	$610,404	$676,306

NUMBER OF METERS

S. Buncombe Water Dist.	538	587	616	694	763	880
Swannanoa Water Dist.	987	1,085	1,163	1,228	1,430	1,731
Beaverdam Water Dist.	121	132	145	160	174	198
Hazel Water Dist.	247	284	309	317	361	404
Venable Water Dist.	116	128	140	151	165	188
Caney Valley Water Dist.	83	98	103	140	158	197
Enka-Candler Community	26	71	78	95	110	142
Sand Hill Community	37	39	42	48	54	66
Johnson School Community	82	100	114	139	154	179
E. Biltmore Water Co.	1	1	1	1	1	1
Total of Above	2,238	2,525	2,711	2,973	3,370	3,986
City of Asheville	11,641	11,682	11,742	11,903	12,152	12,470
Total	13,879	14,207	14,453	14,876	15,522	16,456

CITY OF ASHEVILLE, N.C.
NUMBER OF METERS



CHAS. T. MAIN, INC. BOSTON, MASS.
JANUARY 1949

Actually tne number of meters served is considerably greater because of the following:

a. The East Biltmore Water Co., supplied through a master meter, has about 800 meters.

b. The Biltmore Forest Co., supplied through a master meter, included with the City of Asheville figures, has about 200 meters.

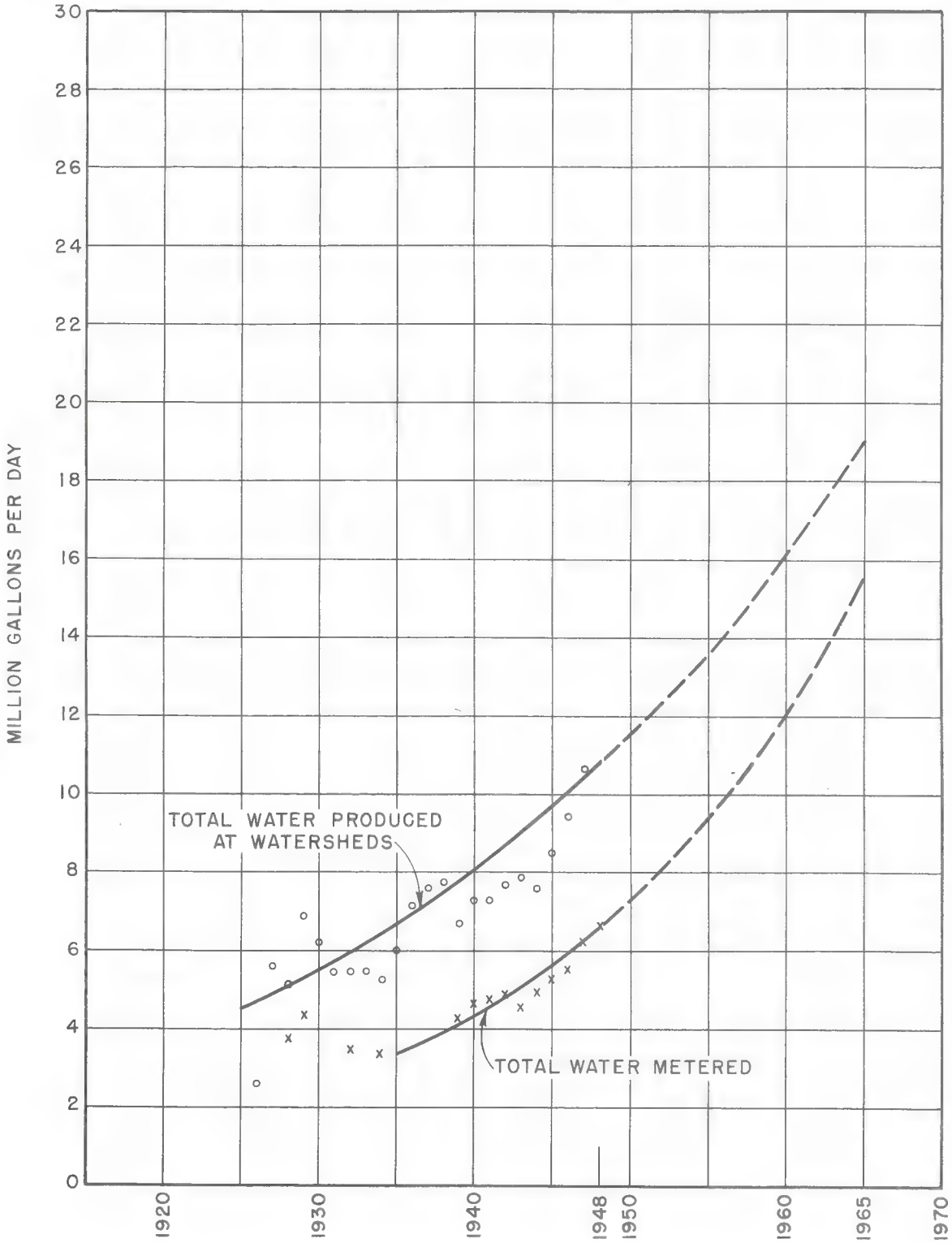
c. The Acton Water Company, included with the Johnson School Community, has about 150 meters.

Thus the total number of meters served for the year ending June 30, 1948 was about 17,600.

As was pointed out earlier, the population of the Metropolitan District outside of Asheville is growing more rapidly than within the city and this growth is shown by the figures tabulated above. For example, in the six year period from 1942 to 1948 inclusive, the average daily consumption outside of the City has increased from 1.35 million gallons per day to 2.34 m.g.d. or an increase of 73%, whereas the corresponding increase within the city, from 3.51 m.g.d. to 4.22 m.g.d., is only 20%. In other words, most of the increased consumption is outside of the City of Asheville.

A similar analysis has been made of the number of meters. In the six year period, the total number of meters read by the city (excluding the meters owned by water companies for which there are master meters as discussed above) has increased from 13,879 to 16,456 or an increase of about 18%. In that period, the number of meters within the city has increased from 11,641 to 12,470 or an increase of about 7%. But outside of the city, exclusive of those supplied by private companies, the increase in meters has been from 2238 to 3986 or an increase of 78%.

CITY OF ASHEVILLE, N.C.
WATER CONSUMPTION



o = CALENDAR YEAR
x = FISCAL YEAR

CHAS. T. MAIN, INC. BOSTON, MASS.
JANUARY 1949

From a study of the monthly records of net consumption, it was determined that the "Unaccounted for Water" tended to be smaller when consumption was high and in such periods tended to be a constant figure. This is due to the fact that certain uses such as drinking fountain, street flushing, etc. could be eliminated during such periods. An examination of the summers of 1945, 1946 and 1947 indicated that an average monthly figure of 3.5 m.g.d. is representative of the "Unaccounted for Water", which includes both the unmetered uses and the leakage and waste, during periods of high demand and low flow on the water sheds, i.e. when the situation is becoming critical.

While the figures of "Metered Consumption" do not include all the uses, they form with suitable allowances a more reliable basis for projecting the demands on the system. These figures were projected to 1965 based on the same accelerating rate of increase which has prevailed for the past ten years. This extension results in an estimated net consumption of 15.5 million gallons per day in 1965. To this was added 3.5 million gallons per day for the unmetered uses of water resulting in a figure of "Gross Consumption" water produced at the watersheds of 19 million gallons per day in 1965.

In view of the increased use of water which has occurred in the past few years, and the fact that greater use of water is a definite result of an increasing standard of living, it is believed that the above figures are conservative and in line with the use of water in comparable cities in the region. It is considered that these forecasts are adequate to provide for both the increase in domestic consumption due to anticipated growth in population and for the increase in demand due to normal industrial expansion.

SUMMARY OF POPULATION AND WATER CONSUMPTION

ASHEVILLE, N.C. AND WATER DISTRICTS

	POPULATION			GROSS CONSUMPTION M.G.D.														
	City of Asheville	Water Districts	Total	Swannanoa Water Dist.	S. Buncombe Water Dist.	Beaverdam Water Dist.	Hazel Water Dist.	Venable Water Dist.	Caney Valley Water Dist.	Enka-Candler Community	Sand Hill Community	Johnson School Community	E. Biltmore Water Co.	Others	Sum of Districts	City of Asheville	Total	Consumption Per Capita G.P.D.
1948	64,000	25,000	89,000	3.00	.23	.04	.08	.05	.04	.22	.01	.07	.16		3.90	7.00	10.90	122
1949	66,000	25,000	91,000	2.90	.24	.04	.10	.05	.04	.25	.01	.07	.17		3.87	7.33	11.20	123
1950	68,000	25,000	93,000	3.05	.24	.04	.10	.05	.04	.26	.01	.08	.18		4.05	7.45	11.50	124
1951	69,000	26,000	95,000	3.22	.25	.05	.11	.05	.04	.26	.01	.09	.19		4.27	7.63	11.90	125
1952	70,500	27,000	97,500	3.40	.25	.05	.11	.06	.04	.26	.01	.09	.19	.08	4.54	7.76	12.30	126
1953	72,000	28,000	100,000	3.58	.26	.05	.11	.06	.04	.27	.01	.10	.20	.09	4.77	7.93	12.70	127
1954	73,500	28,500	102,000	3.80	.27	.06	.12	.06	.04	.27	.01	.11	.21	.10	5.05	8.05	13.10	128
1955	75,000	29,000	104,000	4.08	.28	.06	.13	.06	.04	.28	.01	.12	.22	.12	5.40	8.20	13.60	131
1956	76,500	29,500	106,000	4.27	.29	.07	.14	.06	.04	.29	.01	.12	.24	.14	5.67	8.43	14.10	133
1957	78,000	30,500	108,500	4.53	.30	.07	.14	.07	.04	.30	.01	.13	.25	.16	6.00	8.60	14.60	135
1958	80,000	30,500	110,500	4.77	.31	.08	.15	.07	.04	.31	.01	.14	.26	.19	6.33	8.77	15.10	137
1959	81,500	31,500	113,000	5.06	.32	.09	.16	.07	.05	.31	.01	.16	.27	.22	6.72	8.98	15.70	139
1960	83,000	32,000	115,000	5.35	.33	.10	.17	.07	.05	.32	.01	.17	.28	.25	7.10	9.10	16.20	141
1961	84,500	33,500	118,000	5.66	.34	.10	.18	.07	.05	.32	.01	.18	.30	.29	7.50	9.30	16.80	142
1962	86,000	35,000	121,000	5.97	.35	.11	.19	.08	.05	.32	.01	.20	.31	.34	7.93	9.47	17.40	144
1963	88,000	36,000	124,000	6.24	.36	.12	.19	.08	.05	.33	.01	.21	.33	.38	8.30	9.60	17.90	145
1964	89,500	37,500	127,000	6.57	.37	.13	.20	.08	.05	.33	.01	.23	.34	.45	8.76	9.74	18.50	146
1965	91,000	39,000	130,000	6.86	.38	.14	.21	.08	.05	.33	.02	.24	.35	.53	9.19	9.81	19.00	146

CHAS. T. MAIN, INC.
BOSTON, MASS.

PART II - PROPOSED FACILITIES TO INSURE WATER SUPPLY

From the above table summarizing the trends of population and the anticipated demand for water, it is obvious the yield from the watersheds and the capacity of the present supply lines are certain to be exceeded in the very near future and that the extension of the water supply facilities is imperative to meet future demands.

These facts were anticipated at the time that the Bee Tree Reservoir was constructed, in the 1920's when the city's watershed holdings on North Fork were increased to thirty square miles.

Preliminary Considerations

Studies made at that time indicated that there was an excellent site for an impounding reservoir on the North Fork about one and one-half miles below the junction of the Left and Right Forks, which would provide sufficient storage to increase the safe yield of the North Fork to take care of the city's water supply requirements for many years. From time to time additional studies were made. These studies are summarized in the report of January 31, 1947 made by Mr. Charles Mannel, Consulting Engineer for the City of Asheville. The conclusions of the studies are, briefly, as follows:

There are three available sites on the North Fork Watershed, the "Burnett Site" which utilizes the runoff from the entire watershed, the "Freeman Site" which utilizes 66% of the watershed, and "Site No. 3" which utilizes 58% of the watershed.

The city now owns the North Fork Watershed. The salient data on these sites is summarized in the following table:

	Burnett Site	Freeman Site	Site No. 3
Drainage Area at Site	22.30 sq. mi.	14.65 sq. mi.	12.89 sq. mi.
Per Cent Drainage Area Utilized	100%	66%	58%
Average Runoff	31.8 m.g.d.	20.6 m.g.d.	18.2 m.g.d.
Reservoir Capacity	5500 m.g.	3800 m.g.	2900 m.g.
Average Yield	25 m.g.d.	15 m.g.d.	13 m.g.d.
Comparative Costs	$2,500,000	$2,750,000	$2,850,000

As shown in the above tabulation, these studies indicated that the Burnett site would afford the greatest yield at the least cost.

Accordingly, in 1947 and 1948 the city, with the aid of the Federal Works Agency, undertook topographic surveys of the reservoir area and dam site and let a contract for test borings at the site of the Burnett Dam.

In November, 1948, the City of Asheville entered into an agreement with Chas. T. Main, Inc. of Boston, Massachusetts, for the preparation of a report and contract plans and specifications for the construction of the Burnett Dam and Reservoir and appurtenant work; and the design of a new supply line from the dam to the city's reservoirs.

Design Considerations

Preliminary considerations of the present and future demand for water in the metropolitan area now served by the Water Department of the City of Asheville indicate that the present demand of about 10 m.g.d. will increase to about 19 m.g.d. by 1965 and to 25 m.g.d. in 1975. Since the present day construction cost of the complete facilities necessary to supply a consumption of 25 m.g.d. in 1975 or somewhat later would place an undue debt burden on the city, it is advisable to carry out

the completed work in consecutive steps designed to meet the anticipated demands well in advance of their actual occurrence.

Construction Program

With this in mind it is proposed first to build the Burnett Dam to its ultimate height. Two considerations affected this decision. The borings show that there is no rock foundation within economical depths at the site. Under these conditions an earth dam is indicated and earth dams cannot be readily or economically constructed so as to provide for increasing the height of the dam at a later date. It is also true that a dam of less height than that contemplated would provide less storage at a materially higher cost per million gallons stored. Coincidental with the building of the dam, connection will be made to the present supply lines, and booster pumps, venturi meters and chlorination apparatus installed.

The completion of this step, which it is believed can be accomplished in thirty months from the date of first contract, will meet the present deficiency and provide sufficient water to meet future demands for five or more years from the completion of the dam and booster pumping station.

The second step will be necessary when the demand exceeds 15 m.g.d., which it is estimated may occur between 1955 and 1960. At this time the building of a new supply line will be necessary.

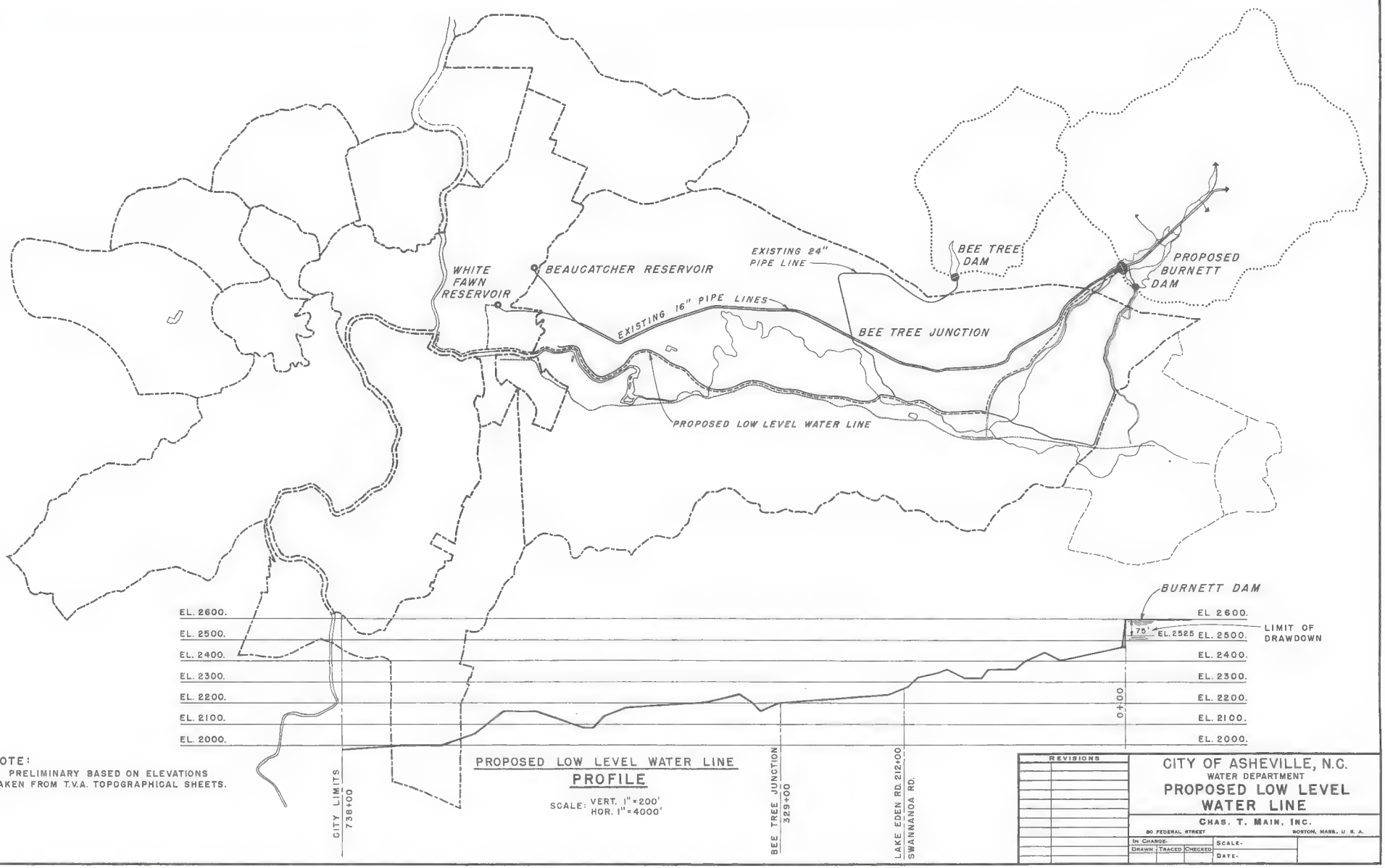
Description of New Facilities

The first step in the construction of new facilities will consist of the construction of the Burnett Dam and Reservoir and the pumping station. The site of the work is about fifteen miles in an easterly

direction from the City of Asheville and about four miles west of the Black Mountain station of the Southern Railroad.

The main dam will be of earth about 1500 ft. long, about 140 ft. maximum height above the river bend, and will contain 1,500,000 cu. yd. of earth and riprap embankment above the original ground surface. South of the main dam there is a depression, across which will be located the saddle dam, which is about 700 ft. long, 65 ft. high, and will contain about 130,000 yd. of embankment. A reinforced concrete spillway channel will be located at the southerly end of the main dam. The spillway overflow will be a concrete weir with structural steel drop gates and motor operated hoists. The concrete conduit for river diversion will be constructed below the present surface of the ground with open cut channels at both ends connecting to the river. This conduit will later be used as a pipe tunnel connected to the intake tower. The intake tower will be located at the upstream toe of the dam and will provide means for regulating the storage in the reservoir and for releasing water to a new 36" supply line. This supply line will be connected with the two existing 36" lines passing under the dam site, and the 16" lines and the 36" lines connected to two booster pumps, each of 5 m.g.d. capacity. In the pump house will also be located venturi meters and chlorination apparatus.

The completion of the construction of the Burnett Dam and Reservoir will materially reduce the existing flood hazard in the valley below the dam. The effect of the reservoir and the proper manipulation of the gates will be to reduce the peak of the flood and smooth out the discharge so that the time of passing the total volume of the flood will be lengthened and the possible damage along the river banks below the new dam will be minimized.



PROPOSED LOW LEVEL WATER LINE

PROFILE

SCALE: VERT. 1" = 200'
HOR. 1" = 4000'

NOTE:
PRELIMINARY BASED ON ELEVATIONS TAKEN FROM T.V.A. TOPOGRAPHICAL SHEETS.

REVISIONS

CITY OF ASHEVILLE, N.C.
WATER DEPARTMENT
PROPOSED LOW LEVEL WATER LINE

CHAS. T. MAIN, INC.
80 FEDERAL STREET BOSTON, MASS., U. S. A.

In Charge				Scale
Drawn	Traced	Checked		Date

Estimated Cost

The estimated cost of the work under the first construction step is as follows:

1.	River Diversion	$ 10,000
2.	Dams	1,600,000
3.	Spillway	290,000
4.	Intake	400,000
5.	Pump House	200,000
	Total	$2,500,000

When the Burnett Dam and Reservoir and the booster pumping station have been completed, the safe yield of the watershed will be increased from its present 9.3 m.g.d. to 15 m.g.d. Pumping from the booster station will be required only for that portion of the year when the flow at the intakes is less than the demand. Pumping will not be required during the spring and other months of high flow. However, when the demand for water exceeds 15 m.g.d., which it is estimated is likely to occur in the months of July and August during the year 1955, it will be necessary to have a new flow line and new supply line to meet the growing demand. The building of this line is the second step in the construction program.

New Low Level Line

Preliminary investigation indicates that a low level supply line following the North Fork valley and then laid parallel to the State Road No. 70 can be built on such grades as to furnish gravity flow to the existing distribution reservoirs and a proposed distribution reservoir in West Asheville. From such calculations as have been made based on

available data, it is believed that a 42" line with a carrying capacity equal to lock joint concrete pipe or a bitumastic line steel pipe should be built as far as Swannanoa. From that point a new 30" line is proposed to extend to the city limits. This 30" line, with the 24" Bee Tree line, would it is believed have sufficient carrying capacity to meet the demands of the city and the outlying water districts until at least the year 1975. After the new low level line, the two existing 16" lines from the North Fork will be no longer needed and the pipe for these lines can be released for use elsewhere. From the city limits a new 24" line is proposed to be connected to the White Fawn and Beaucatcher Reservoirs. Along the route of the new line loop line connections are proposed to be made to the existing distribution system in Swannanoa and takeoff outlets located at convenient intervals for the extension of the distribution system in the territory adjacent the new low level line.

Estimated Cost

No surveys have been made of the route to this line. However, based on such information as is available, it is estimated that the cost of the new line is approximately as follows:

Right of Way	$ 30,000
42" Line Burnett Dam to Swannanoa, 29,000 ft.	820,000
Takeoffs and Incidentals - ± 7.5%	62,000
30" Line Swannanoa to Biltmore Station, 50,500 ft.	910,000
Takeoff and Incidentals - 7.5%	68,000
24" Line City Limits to White Fawn Reservoir, 6000 ft.	100,000
Incidentals - 10%	10,000
Field Engineering and Contingencies - 12.5%	250,000
Total	$2,250,000

PART III - METHOD OF FINANCING NEW CONSTRUCTION

The estimated cost of the Burnett Dam and Reservoir, including the booster pumping station, is $2,500,000. After conference with the City Manager and the Director of Public Works, it is recommended that the city raise this money through a bond issue and submit the matter to the vote of the people at a special election to be called by the City Council. These bonds will be secured by the general taxing power of the city. It is the general opinion that the interest rate may be 3 to 3-1/4%.

In addition to the Debt Service, there will be certain additional operating costs. The tabulation below shows the net additional charges which will be required in 1952 on the completion of the dam, taking into account the greater revenue due to the increased consumption in 1952, together with the Debt Service of $2,500,000. The estimated revenue is based on maintaining the present charges for water. It is assumed that, except for the items given, all other costs will remain at their 1948 level.

Debt Service

Interest 3-1/4% of $2,500,000	$81,250	
Sinking Fund 40 years at 3-1/4%	31,350	
Sub-total		$112,600

Additional Operating Costs

Power for Pumping	6,500	
Cost of Chlorination	800	
Additional Labor Costs	6,000	
Supervision	500	
Miscellaneous	700	
Sub-total		14,500
Total Additional Cost in 1952		$127,100
Increase in Revenue Due to Increased Consumption of Water in 1952		94,000
Net Increase in Additional Annual Cost		$ 33,100

Basis of Meeting Additional Annual Cost

Various methods of meeting this increase in additional annual costs have been studied. Of these, two methods appeared worthy of careful consideration; one, an increase in rates for consumers outside the city limits, and two, the provision of the additional cost from existing Water Department revenue.

Increase Outside of the City

Regarding water consumers outside the city, the policy of the Water Department of the City of Asheville is not in accord with that of similar cities in the general region, as will be noted from the tabulation below:

COMPARISON OF WATER RATES

		Inside City		Outside City	
		7,500 gals. per Month	75,000 gals. per Month	7,500 gals. per Month	75,000 gals. per Month
Fayetteville,	N.C.	$1.38	$13.75	$2.13	$14.50
Winston-Salem,	N.C.	2.10	19.68	4.20	39.36
High Point,	N.C.	2.33	16.54	5.00	50.00
Charlotte,	N.C.	2.22	20.89	2.96	27.85
Greenville,	S.C.	1.88	11.25	2.81	16.87
Spartanburg,	S.C.	2.10	18.08	2.42	20.79
Danville,	Va.	1.60	16.00	2.40	24.00
Kingsport,	Tenn.	3.25	24.25	4.88	36.38
Columbus,	Ga.	1.13	11.25	1.50	15.00
Nashville,	Tenn.	1.30	11.00	2.60	22.00
Raleigh,	N.C.	2.25	21.45	4.50	42.90

The alternate method is to obtain the additional money from the existing Water Department revenue. It is our opinion that this method should be used primarily because of two considerations. First, this amount $33,100 can easily be absorbed from net earnings now allocated to general funds from the Water Department. Secondly, additional funds

will have to be secured when the new low level pipe line is built - about 1954.

This line is estimated to cost approximately $2,250,000 and is the second necessary step in the extension of the water facilities of the City of Asheville. It is our opinion that the additional revenue necessary to financing the construction of the new low level line should be secured from an increase in rates to customers in the water districts and communities outside of the city. As noted in the body of this report, there are over five hundred miles of distribution pipe lines in the water districts outside of the city and the same mileage inside the city limits. However, since the population outside of the city is about one-half that inside the city, there are twice as many miles of pipe line per customer in the county as in the city. This fact alone warrants an increase in rates to customers outside the city limits.

Respectfully submitted,

CHAS. T. MAIN, INC.

By R. A. Moncrieff

R. A. Moncrieff